Fermilab

TM-974
2701.000
June 1980

EXPERIMENTAL INVESTIGATION OF THERMAL CONTRACTION FOR FIBER-REINFORCED EPOXY RESINS, COMMON PLASTICS, AND OTHER MATERIALS

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June 1980

INTRODUCTION

Candidate materials for the layer-to-layer insulation in the 30-inch Bubble Chamber coil conversion include fiber-reinforced epoxy resins. One criterion of a suitable material is its thermal contraction. This paper presents data obtained on thermal contraction using a device constructed by Moyses Kuchnir (see the Appendix for a description of the device).

The following table lists the material tested, the measured contraction between room temperature and LN_2 temperature, the investigator and any values of thermal contraction given in the literature. The first sample listed is stainless steel type 304, which was measured as an indication of experimental error. At least 6 data points were obtained for every material listed. The repeatability of the experiment is excellent. Randolite was measured in February of 1980, yielding a value of $\Delta L/L = 0.00127$. Then in June, six different Randolite samples were manufactured and tested. The average value of the tests was 0.00130.

When it was not possible to test a single piece of material because it was in sheet form, a stack-up was made. This stack-up consisted of pieces

epoxied together and clamped together tightly. Therefore the effect of the epoxy was probably quite small. Where values are cited from the literature, they came from one of two sources, either the Cryogenic Materials Handbook by Fred Schwartz or The LNG Materials And Fluids Handbook by Douglas Mann.

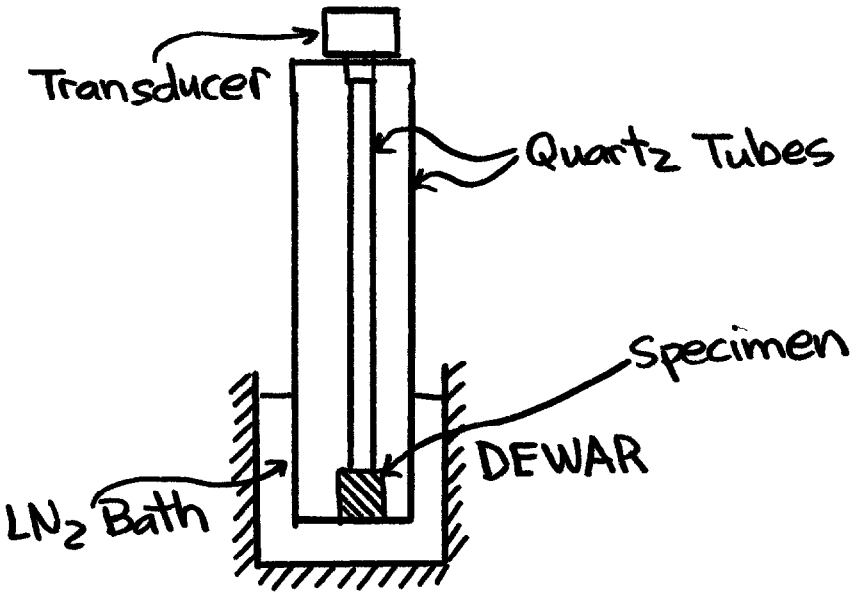
Room Temp to LN_2

Material	Measured $\Delta L/L$	Reference $\Delta L/L$	Investigator
304 Stainless Steel	0.00282	0.00277	M. Mruzek
G-10 plate, perpendicular to fibers	0.00694		M. Mruzek
G-10 plate, parallel to fibers	0.00202		M. Mruzek
Ohio Brass High Lite Rod parallel to fibers	0.00131	Manufacturer gives 0.00119 at room temp.	M. Mruzek
U.S. Polymeric Yellow EF-7172 Laminate Lot 2W4321	0.00447		M. Mruzek
U.S. Polymeric Type 7160 Unidirectional perpendicular to fibers	0.00291		M. Mruzek
Randolite Black Rod parallel to 80% of fibers	0.00127		M. Mruzek
G-10 Sheet 0.039 thick perpendicular to fibers	0.00511		M. Mruzek
Ohio Brass Highlite Rod perpendicular to fibers	0.0041		W. Craddock
Scotch Ply 1009-26 perpendicular to fibers	0.00371		W. Craddock
Scotch Ply SP-250 E perpendicular to fibers	0.00547		W. Craddock

Material	Measured $\Delta L/L$	Reference $\Delta L/L$	Investigator
Scotch Ply 1002 crossply, perpendicular to fibers	0.00386		M. Mruzek
Micaply 0.062" thick EG 818 0/0 Type GF	0.00477		M. Mruzek
Fermilab Micarta Rod Measured along axis	0.00263		M. Mruzek
Randolite Rod, measured perpendicular to axis	0.00400		S. Bonifas
Poly Vinyl Chloride	0.00959	0.00822	S. Bonifas
Delrin, Acetal Resin	0.0142		S. Bonifas
Teflon	0.0207	0.0187	S. Bonifas
G-10 CR, parallel to fibers	0.00225	0.00213	S. Bonifas
Nylon	0.0124	0.0127	S. Bonifas
Wooden Dowel Along axis	0.000658		M. Mruzek

Appendix

The thermal contraction apparatus is shown schematically below:



The specimen is placed in a 1" O.D. capped quartz tube which has an opening machined in its side. Inside the tube is a much smaller quartz tube which transmits the deflection to a linear transducer above it. With a knowledge of the room temperature length (measured with calipers) and the change in length measured with the transducer, the thermal contraction can be calculated. Typically the length of the specimen tested was around 7/10 of an inch. The deflection was measured on cooldown and again on warm up. Thus each LN_2 immersion yields two data points.